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## C3Or3D-03: MCTB Cryogenic Systems Design and Analysis

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The Magnet Cold Test Bench (MCTB) cryogenic systems are composed of one as-built LHE plant, Cryolines with Interconnection Valve Box (IVB) which are under development, and MCTB auxiliary System. MCTB tests include phase I: CICC jumper test, and phase II: full TF magnet test. The MCTB cryogenic systems are specifically designed and tailored for cryogenic clients such as TF coils, LTS busbars, TF case, Magnet Supports and Shields at 4.5K, as well as the HTS current leads at 50K. The average equivalent cooling power of one LHE Plant is 25kW at 4.5K, which needs to be turned down to approximately 5kW at 4.5K to meet the heat load requirements of magnet testing. A total of approximately 150 meters of cryogenic transfer lines are used to transport and distribute helium to the Coil Terminal Box (CTB) and TF magnet. The IVB serves to connect the CTB with the Cryoplant and condition helium states.

This paper presents the design and development progress of the new cryogenic system and highlights the challenges encountered. It also includes an analysis of the cryogenic plant's customized turndown performance tailored to the MCTB's requirements, supported by simulations and dynamic analyses of heat loads under various operating scenarios. These studies provide practical insights for the MCTB commissioning and future cold tests.

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